MAGNUM
E N E R G Y

ME-BMK/ME-BMK-NS
Battery Monitor Kit

Owner's Manual

Disclaimer of Liability

The use of this manual and the conditions or methods of installation, operation, use, and maintenance of the ME-BMK is beyond the control of Magnum Energy, Inc. Therefore, this company assumes no responsibility and expressly disclaims any liability for loss, damage, or expense whether direct, indirect, consequential, or incidental that may arise out of or be in anyway connected with such installation, operation, use, or maintenance.

Due to continuous improvements and product updates, the images shown in this manual may not exactly match the unit purchased.

Restrictions on Use

The ME-BMK may only be used in life-support devices or systems with the express written approval of Magnum Energy. Failure of the ME-BMK can reasonably be expected to cause the failure of that life-support device or system, or to affect the safety or effectiveness of that device or system. If the ME-BMK fails, it is reasonable to assume that the health of the user or other persons may be endangered.

IMPORTANT PRODUCT SAFETY INSTRUCTIONS

This manual contains important safety instructions that must be followed during the installation and operation of this product. Read all instructions and safety information contained in this manual before installing or using this product.

- All electrical work must be performed in accordance with local, state, and federal electrical codes.
- This product is designed for indoor/compartment installation. It must not be exposed to rain, snow, moisture, or liquids of any type.
- Use insulated tools to reduce the chance of electrical shock or accidental short circuits.
- Remove all jewelry such as rings, watches, bracelets, etc., when installing or performing maintenance on the ME-BMK and the inverter system.
- Always disconnect the batteries or energy source prior to installing or performing maintenance on the ME-BMK and inverter system. Live power may be present at more than one point since an inverter utilizes both batteries and AC. Turning off the inverter may not reduce this risk. As long as AC power is connected, it will pass through the inverter regardless of the power switch on the inverter or the ON/OFF INVERTER pushbutton on the remote.

Safety Symbols

To reduce the risk of electrical shock, fire, or other safety hazard, the following safety symbols have been placed throughout this manual to indicate dangerous and important safety instructions.

WARNING: This symbol indicates that failure to take a specified action could result in physical harm to the user.

CAUTION: This symbol indicates that failure to take a specified action could result in damage to the equipment.

Info: This symbol indicates information that emphasizes or supplements important points of the main text.

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1.0 Introduction

The ME-BMK/ME-BMK-NS is a single battery bank amp-hour meter that monitors and provides important information about the condition of the battery. This information will let you know how much energy you have available, and let you plan your electrical usage to ensure the battery is not being over-discharged.

The ME-BMK is easy to install and is designed to be networked with a Magnum Energy inverter/charger using a remote (ME-RC50 or ME-ARC50) or router (ME-RTR) to display information about your battery bank.

> **Info:** The ME-BMK-NS is identical to the ME-BMK except the NS version does **not** have the DC shunt.

1.1 Product Features

- Compatible with 12, 24, or 48 volt systems
- Adjustable settings – very easy set up
- All battery meter and Magnum inverter/charger setup and monitoring features are in a single convenient display – doesn't require multiple displays for inverter and battery system info
- Displays reliable and pertinent information, such as:
    - Battery State of Charge (SOC)
    - Battery Voltage
    - Battery Current
- Auto-detecting input voltage
- Temperature and battery bank capacity automatically compensated and coordinated between inverter and battery monitor
- Precision 500A/50mv DC shunt (**not** included w/ ME-BMK-NS model)
- Automatic efficiency calculation

1.2 Identification and Compatibility

The ME-BMK is compatible with all Magnum inverters/chargers that have been provided with a Magnum Net or Network port (see Figure 2-1). The ME-BMK requires either an ME-RC50 (revision 2.0 or higher) remote, ME-ARC50 remote, or an ME-RTR router to access the available settings and features.

> **Info:** You can view the revision level of your ME-RC50 when you first power-up the remote, or by pushing the **TECH** button and accessing the *02 Revisions* menu.

If your ME-RC50 remote's revision is not 2.0 or higher, refer to one of the two options below to obtain the required revision.

1) If the ME-BMK is being installed at the same time as a newly purchased Magnum inverter and ME-RC50 remote system, contact your Magnum Energy dealer to obtain the ME-RC50 with a revision of 2.0 or higher.

2) If the ME-BMK is being added to a previously installed Magnum inverter and ME-RC50 remote system, contact Magnum Energy about the ME-RC50 upgrade options.

Why should I use the Magnum Battery Monitor? To ensure your batteries perform satisfactorily and have a long life, they need to be properly maintained and charged. There are several devices that help to determine if the batteries are being fully charged:

- **DC Voltmeter**: An accurate DC voltmeter can be used to measure the Open Circuit Voltage (OCV) across the battery terminals and compare the readings with the OCV values from the battery manufacturer. A DC voltmeter is the least costly, but is also the least accurate and requires the batteries to be "at rest". This rest requirement means the voltage measurement should only be done when there is no current moving through the battery for a period of time (most experts say a minimum of 1 hour). Using a DC voltmeter when the batteries are at rest is generally impractical because the batteries are usually always powering loads or being charged.

- **Hydrometer**: A good hydrometer can be used to measure the concentration of battery electrolyte in each individual cell, and compare these readings with the specific gravity values from the battery manufacturer. A hydrometer is very accurate, but can be time-consuming and becomes unpleasant when working with sulfuric acid. A hydrometer won't work with sealed batteries.

- **Amp-hour Meter**: An amp-hour meter is an electronic measuring device that uses a precision shunt to calculate the amp-hours going into (charging) and coming out of (discharging) a battery. This meter tracks the amp-hour usage and compares it against the amp-hour capacity of the battery to determine its charge condition. Calculating *amp-hours in* vs. *amp-hours out* is fairly accurate and easily displayed, but doesn't provide an accurate State Of Charge (SOC) under all charge and discharge conditions.

These devices have both advantages and disadvantages based on accuracy and ease of use. The Magnum Energy battery monitor combines the advantages of these devices with additional functionality (such as monitoring battery temperature and calculating battery efficiencies) to provide an easy and more accurate means to determine the battery's SOC condition. Therefore, you are more likely to keep the batteries properly charged, and in turn be satisfied with your battery system performance.

What is the difference between Amps and Amp-Hrs? "Amps" indicate the flow of current going in or out of the battery. "Amp-hours" indicate the amount of current returned to or removed from the battery. Amp-hrs are a common rating used to calculate the battery's available capacity. For example, if a constant 3 amperes were removed from a 100 AH battery each hour, the battery bank's capacity would be 94 AH after 2 hours (6 amp-hours less).

To help understand the difference, imagine the battery bank is equivalent to a water tank. Viewing the amps display would be similar to watching a water gauge. You can see that the water is flowing a little or a lot, but this doesn't indicate how much water is left. When viewing the SOC display, it would be similar to viewing the water tank's level indicator, which tells you how much water is left in the tank.

For example: You have a 10 gallon water tank, and you remove water from the tank with a one gallon bucket. The water level indicator would show the available water has decreased by 10% – leaving 90% of the water still available. If this was a battery bank, then you would know that 10 percent of the battery's capacity has been used and its SOC is now 90%.

2.0 Installation

Before installing the ME-BMK, read this entire section so you can thoroughly plan the details to ensure the overall system requirements are accomplished.

To assist in planning and designing your installation, review the basic system diagram in Figure 2-1. If another network device besides the ME-BMK is to be installed, refer to Section 2.3 to determine your specific network configuration.

WARNING: Installations should be performed by qualified personnel, such as a licensed or certified electrician. It is the installer's responsibility to determine which safety codes apply and to ensure that all applicable installation requirements are followed. Applicable installation codes vary depending on the specific location and application. Review the "Important Product Safety Information" on page *ii* before any installation.

The ME-BMK Sense Module is connected to the inverter by a 10' communications cable, and to the DC shunt using a 5' twisted-pair signal wire. Before installing and connecting any wires, determine the following routes:

> 1) The communications cable route throughout the home or vehicle/boat to the inverter.
>
> 2) The twisted-pair signal wire route to the shunt.

Info: The communications cable may be extended beyond the supplied 10', but to ensure voltage accuracy do not extend the 5' twisted-pair wire used between the DC shunt and the Sense Module.

Info: For information on the size of the battery cable and overcurrent protection device to be used in the installation, refer to the inverter owner's manual.

2.1 Required Components and Tools

2.1.1 List of Supplied Components in the ME-BMK/ME-BMK-NS:

- ME-BMK/ME-BMK-NS Owner's Manual
- Sense Module (with two #8 x 3/4" Phillips mounting screws)
- 500A/50mv DC shunt (with two #8 x 3/4" Phillips mounting screws)*
- 10ft Communications cable
- 5ft Twisted-pair (blue and orange color) signal wires

2.1.2 List of Other Required Equipment and Materials:

- Magnum inverter with a network port
- ME-RC50 (revision ≥ 2.0) remote, ME-ARC50 remote, or an ME-RTR router
- Batteries (with appropriately sized cables)
- Short (~18") battery cable (to connect shunt to battery negative)
- In-line fuse holder (with 2-amp DC fuse)
- 4-Wire phone-splitter (if using multiple network devices)

2.1.3 Tools Required to Install the ME-BMK:

- Flat-blade screwdrivers (1/4" and 1/8" blades)
- #2 Phillips screwdriver
- 9/16" open-end wrench or adjustable crescent wrench

> *The ME-BMK includes a shunt, the ME-BMK-NS does not.*

Network Port
(green label)

Magnum Energy Inverter/Charger
(with NETWORK port)

Remote Control
(ME - RC50 with revision ≥ 2.0,
ME - ARC50, ME - RTR)

Inverting
DC 126V 5A

Sense Module
(ME - BMK/ME - BMK - NS)

Communications Cable (10')
(from ME - BMK/ME - BMK - NS)

DC
Negative
Distribution

**Battery
Disconnect
Switch**

ON

OFF

DC Shunt*
(ME - BMK)

load
side

battery
side

**Twisted-Pair
Cable (5')**
(ME - BMK/
ME - BMK - NS)

DC Fuse
(2 amps)

**Battery /
Inverter
Cable
Fuse**

CLASS T FUSE

*NOTE: The ME - BMK - NS
model does not include a
DC shunt. The shunt **must**
be provided in the system.

**Battery
Bank**

DC
Positive
Distribution

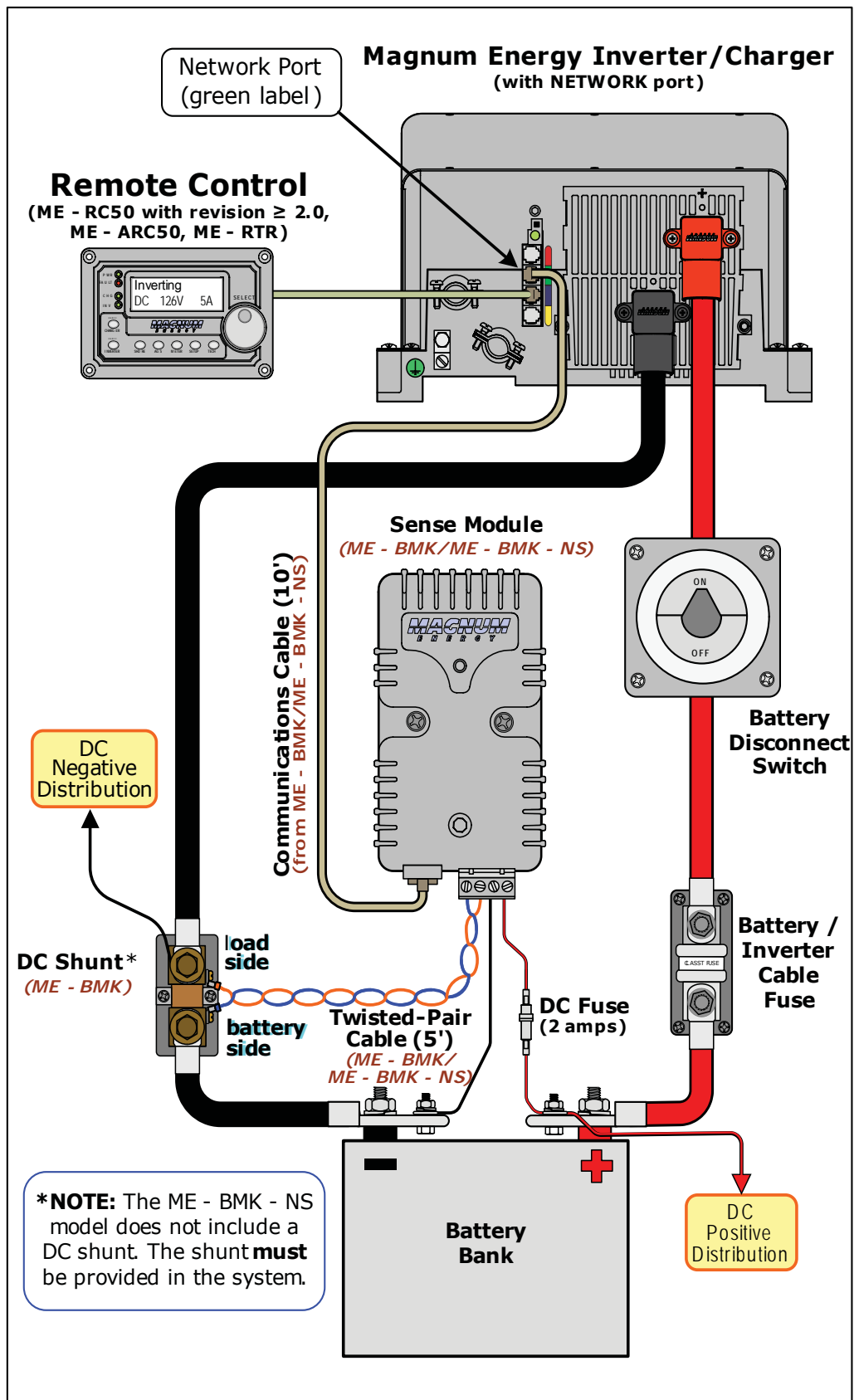*Figure 2-1, ME-BMK Installation Diagram*

2.2 Installation Procedure

Select a location that is dry and away from extreme temperatures to mount the ME-BMK Sense Module and DC shunt. Use the supplied #8 x 3/4 screws (x4). Allow ample room to view the LED on the Sense Module, access the screws and bolts on the shunt, and to access the terminal block and the RJ11 port.

⚠️ **CAUTION:** Do not mount the ME-BMK Sense Module in a closed battery compartment, or in an area where water or any other liquid can enter the ME-BMK Sense Module and cause shorting or corrosion. The internal circuit board is conformal coated to help prevent corrosion, but this failure is not covered by the warranty.

ℹ️ **Info:** Shunts should be mounted in an area where freely circulating air is available. For continuous operation, it is recommended that shunts are not used at more than 2/3 of their rated current. If this is not possible, adequate forced ventilation should be provided to keep the shunt operating temperature below 60°C.

⚠️ **CAUTION:** Before beginning the installation, ensure all AC power is disconnected from the inverter, and all negative and positive battery cables are disconnected from the battery bank.

2.2.1 DC Cable Connections

1. Using an appropriate sized cable, wire the inverter's DC negative terminal to the DC shunt (load side).

ℹ️ **Info:** For the ME-BMK to monitor all load currents, all DC loads — including the inverter — must be connected to the load side of the shunt.

2. Wire the other side of the DC shunt (battery side) to the battery negative terminal. Connect cables/hardware to the shunt exactly as shown in Figure 2-2.

3. Using an appropriate sized cable, wire the inverter's DC positive terminal to the load side of an appropriate DC disconnect/overcurrent protection device (i.e., DC circuit breaker, or DC disconnect and fuse).

4. Open the DC circuit breaker (or remove the fuse) and wire its other side to the positive terminal of the battery bank.

Sense wire with ring terminal to Sense Module (x2)
Flat washer (x2)
Split-lock washer (x2)
8-32 x 3/8" screw (x2)

3/8"-16 bolt with 9/16" head (x2)
Split-lock washer (x2)
Flat washer (x2)
Cable (x2) – one side to inverter, other to battery (use ring lug w/ 3/8" opening)
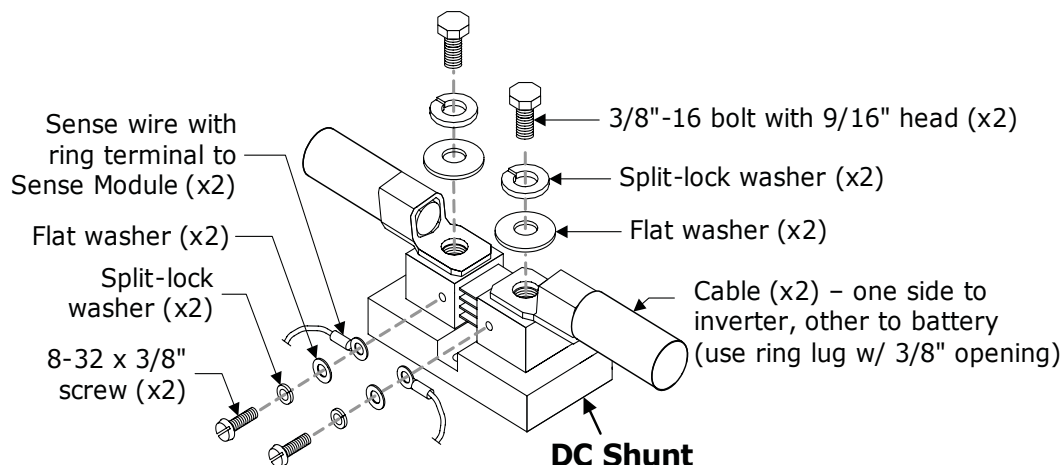
DC Shunt

Figure 2-2, DC Shunt Connections

2.2.2 ME-BMK Sense Module Connections

Once mounted, complete the following steps to connect the BMK (Fig. 2-3):

1. Run the communications cable between the ME-BMK Sense Module and the inverter/charger. This cable is a 2-wire, twisted-pair, telephony standard with RJ11 connectors on each end. A standard telephone cable may be substituted if the provided remote cable is not able to be used or needs to be longer.

2. Connect the communications cable to the RJ11 Net port beside the green label (Network port) on the Magnum inverter/charger (see Figure 2-1).

3. Unplug the 4-port terminal block from the Sense Module and ensure the openings are unscrewed enough to allow wire insertion.

4. Using the supplied 5 foot twisted-pair wire: 1) Connect the <u>blue wire</u> from the #1 terminal on the 4-port terminal block to the small screw on the **battery side** of the shunt (negative shunt sense connection); then, 2) Connect the <u>orange wire</u> from the #2 terminal on the 4-port terminal block to the small screw on the **load side** of the shunt (positive shunt sense connection).

Info: Ensure these blue and orange wires stay twisted together up to the shunt to maintain accuracy.

5. Connect a wire (black) from terminal #3 on the 4-port terminal block to the negative terminal of the battery. Then, connect a wire (red) with a 2-amp in-line fuse from terminal #4 on the 4-port terminal block to the positive terminal of the battery.

CAUTION: To prevent damage, the black and red power wires <u>must</u> <u>not</u> be connected to the input sense terminals (terminals #1 and #2).

6. When all the connections are made and checked, plug the 4-port terminal block into the Sense Module and then close the DC circuit breaker (or DC disconnect) to supply power to the inverter and Sense Module.

7. Immediately after applying DC power, the LED on the Sense Module should come on as the unit goes through a power-up self-test. After the initial self-test completes, the LED should be green. If so, your battery monitor system is now ready for setup; if not, please refer to the Troubleshooting section.
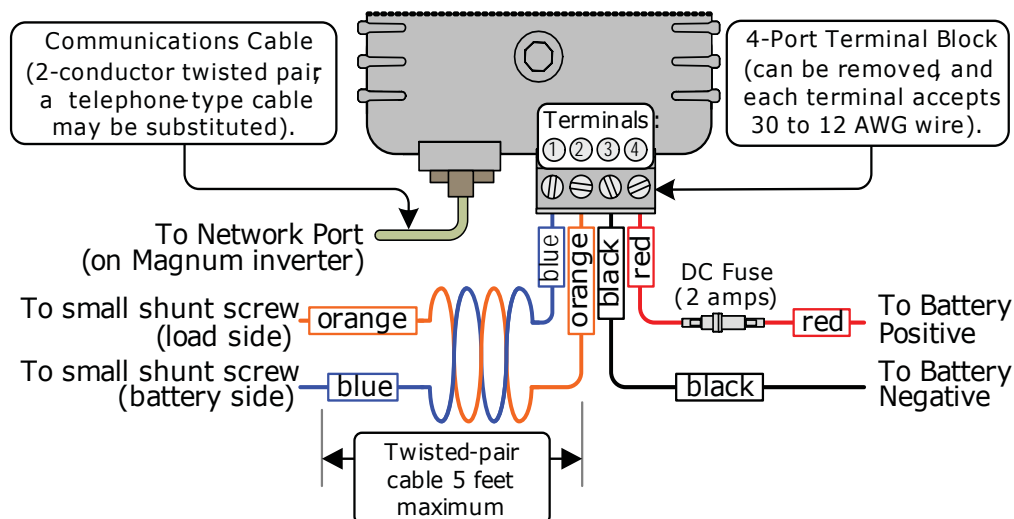
Figure 2-3, Sense Module Connections

2.3 Network Connection with Multiple Devices

If you are using more than one Magnum Energy networked device, a 4-wire phone-splitter is required to connect the network devices. It is possible to interconnect the devices in two configurations; either in a Star or a Daisy Chain configuration.

> **Info:** Before deciding on which configuration to use, review the differences in installation and ease of troubleshooting.

• **Star Configuration** - In this arrangement, all the network devices connect to the inverter's Network port via a phone-splitter, using individual cable runs (see Figure 2-4). Since each device is independently connected to the inverter's Magnum Net or Network port, problems in a cable or a device can be easily isolated; and, if there is a cable failure to one device it does not bring down all the other devices.
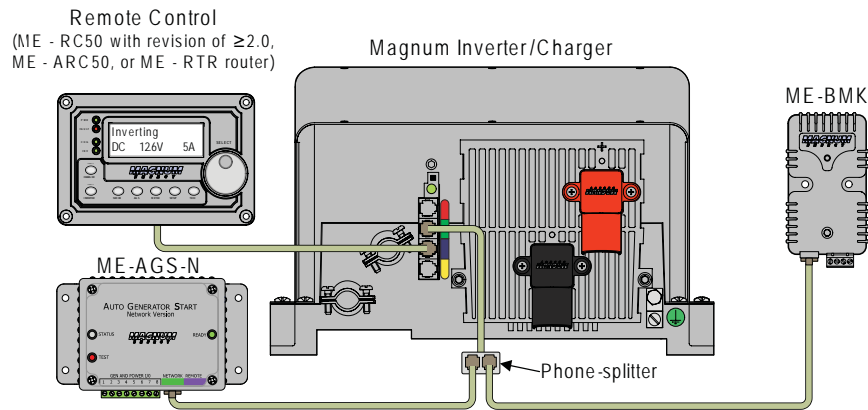
Figure 2-4, Multiple Network Devices - Star Configuration

• **Daisy Chain Configuration** – In this arrangement, the network devices are linked in a series (see Figure 2-5). If using this configuration, the ME-AGS-N must be the first device connected to the inverter's Magnum Net or Network port – followed by the ME-BMK.
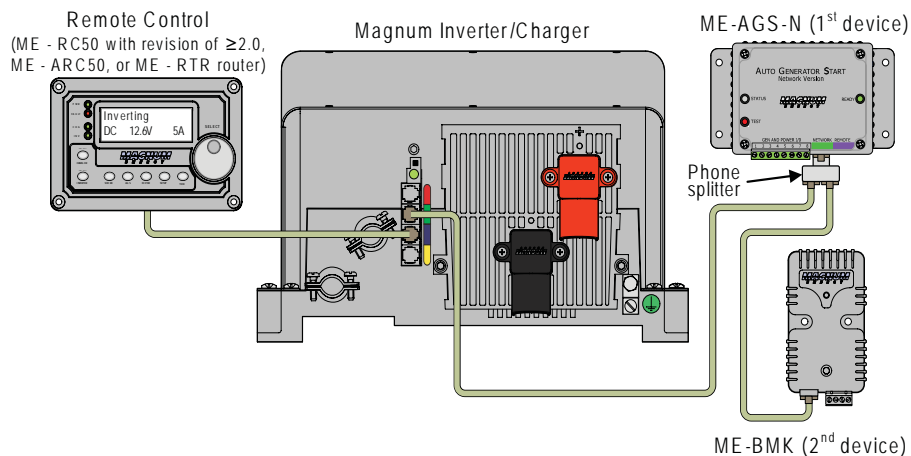
Figure 2-5, Multiple Network Devices - Daisy Chain Configuration

2.4 Network Connections Using the ME-RTR Router

If you are using a Magnum Energy router it is possible to connect the BMK either directly to the router, or directly to the inverter.

- **Direct to Router Configuration** – In this arrangement, the BMK device is directly connected to the router which is in turn connected to the inverter.

Magnum Energy Router
(ME-RTR)

Magnum Inverter/Charger

ME-BMK
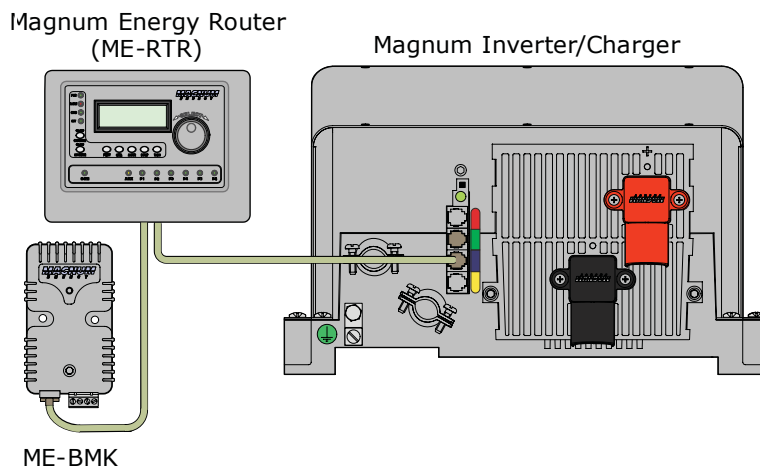
Figure 2-6, BMK Connected Directly to Router

- **Direct to Inverter** – In this arrangement, the router and BMK device are each directly connected to the inverter via separate ports.

Magnum Energy Router
(ME-RTR)

Magnum Inverter/Charger

ME-BMK
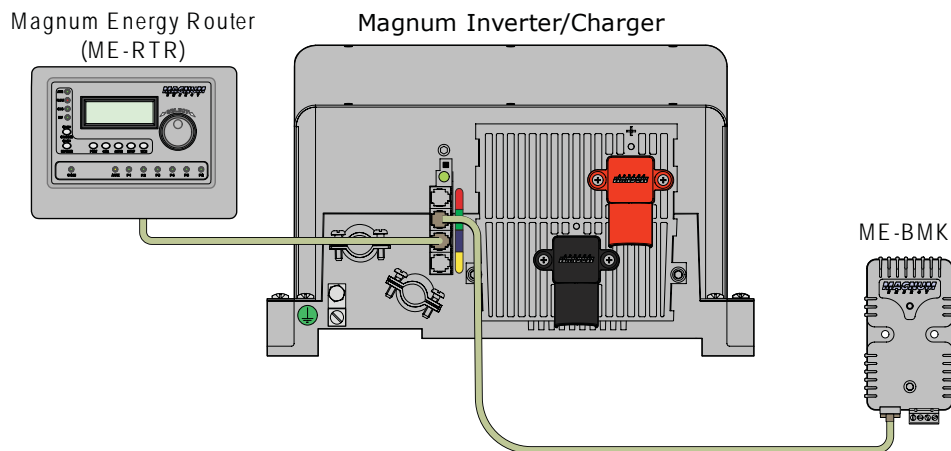
Figure 2-7, BMK and Router w/ Separate Connections to Inverter

3.0 Using the ME-RC50 Remote with the BMK

This section discusses how to set up and operate the BMK using the ME-RC50 remote. It also shows what BMK menu options are available using this remote.

The first section provides information about Charge Efficiency and how to manually access/adjust this setting. Normally, the ME-BMK battery monitor automatically calculates the battery's efficiency.

> **Info:** The factory default charge efficiency setting is *Auto.* This setting allows the charging efficiency to be automatically calculated. In most circumstances, the *Auto* setting will determine the best charge efficiency.

> **CAUTION:** If you do not know your battery's charging efficiency, leave it at the factory default setting. If the setting is manually set but incorrect, the state-of-charge information will become more inaccurate with every charge.

What is Charge Efficiency? When a certain amount of energy is removed or discharged from the battery, this removed energy will need to be returned to keep the batteries at a 100% state of charge. As batteries are being charged, they lose energy; either in the form of heat, or while gassing. This loss of energy while charging means the battery will not be fully charged if you only return the current that was removed. To compensate for the battery's inefficiencies while charging, a charge efficiency setting is provided. The charge efficiency setting compensates the AH I/O (Amp-Hrs In/Out) reading by ensuring the amp-hrs returned to the battery are greater than the amp-hrs removed.

For example, if your AH I/O display reads 000 and you begin powering a 25 amp load for two hours, the display will show -050. This indicates that you have discharged 50 amp-hrs (2 x 25) from the battery. If the charge efficiency setting is set to 95%, then as you begin charging and return 50 amp-hrs, the AH I/O reading will be less than zero, indicating that the amp-hours removed have not been fully returned. The 95% charge efficiency setting requires 52.5 amp-hours (50/95) to be returned before the AH I/O returns to 0.

3.1 Accessing the Charge Efficiency Menu Item

On the ME-RC50 remote, press the **METER** pushbutton and rotate the **SELECT** knob until the *05 BM: Setup* menu appears. Once the *05 BM: Setup* menu appears, press the **SELECT** knob to access the BM *Charge Eff* menu item (see Figure 3-1).

METER

press

rotate to

Status...
05 BM: Setup

press to select
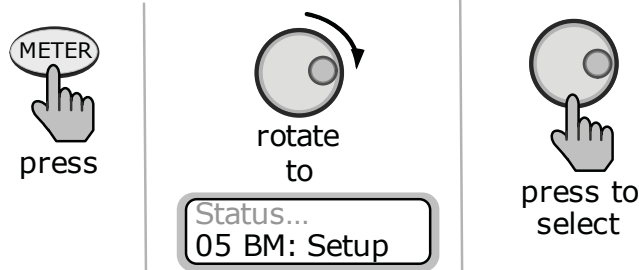
Figure 3-1, Accessing the Charge Efficiency Menu Item (ME-RC50)

> **Info:** For additional information on navigating the remote display, see the ME-RC50 (PN: 64-0003) Owner's Manual. See Figure 3-4 for a complete map of the menu items and adjustable settings available for the ME-BMK when using the ME-RC50 remote control.

3.2 Adjusting the Charge Efficiency Setting

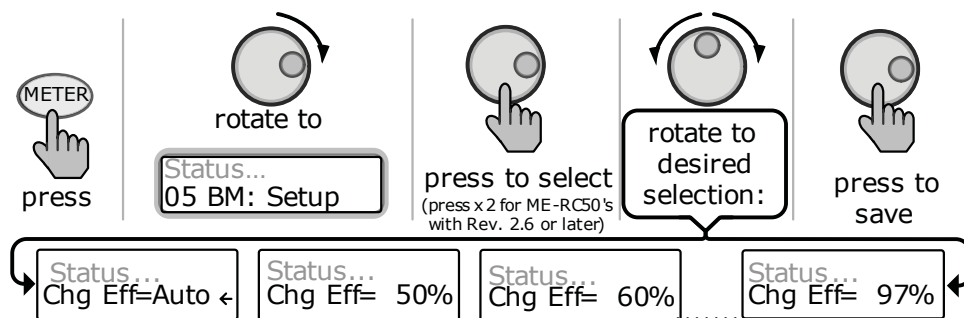The Charge Efficiency setting allows the battery monitor to calculate the battery's charge efficiency. The charge efficiency can be calculated automatically using the *Auto* setting, or can be manually programmed by the user (see Figure 3-2).

The battery monitor is shipped with the charge efficiency set to *Auto*. This allows the battery monitor to automatically calculate variables that affect the charging efficiency such as battery type, battery age, and how the batteries are maintained – which is not always constant. With the *Auto* setting, the efficiency is recalculated each time the batteries reach a 100% state of charge.

This setting can also be manually adjusted from 50% to 97% if the battery's charge efficiency is known. When using a setting other than the *Auto* setting, the battery monitor will use the manual setting to calculate the AH I/O display. For example, if you set the charge efficiency to 90% and 100 amp-hrs are removed from the battery, the *AH Net* display would read 000 only after 111AH have been returned to the battery.

Figure 3-2, *Adjusting the Charge Efficiency Setting (ME-RC50)*

If the charge efficiency is manually set and inaccurate, the SOC information will be more inaccurate with every charge. For this reason, continually monitor the AH I/O reading under the remote's **METER** pushbutton.

To access the AH I/O reading: press the **METER** pushbutton, turn the **SELECT** knob until the *03 BM: Meters* menu appears, press the **SELECT** knob again, and then turn the **SELECT** knob until the *AH I/O:* display appears.

After several charge and discharge cycles (below 80% SOC), the AH I/O reading should be slightly positive when the *SOC* display reads 99%.

To view the *SOC* display: press the **METER** pushbutton, turn the **SELECT** knob until the *02 BM: SOC* menu appears. If the AH I/O reading is below 000 (negative number) when the *SOC* display reads 99%, then increase the charge efficiency setting. If you find that the AH I/O reading is substantially above zero when the *SOC* display reads 99%, then decrease the charge efficiency setting.

3.3 Adjusting the Batt AmpHrs Setting

It's important that the Batt Amphrs setting is correct or else the calculations used to determine the battery's *SOC* display will be inaccurate.

- **ME-RC50 Remote (Revision 2.0-2.5):** To adjust this setting, press the **SETUP** pushbutton on the ME-RC50 remote control, and then rotate the **SELECT** knob until the display shows the *03 Batt AmpHrs* menu. When the *03 Batt AmpHrs* menu appears, press the **SELECT** knob to display the current Batt AmpHrs setting. Turn the **SELECT** knob to adjust the Batt AmpHrs setting. Press the **SELECT** knob to select and save the new setting.

Using the ME-RC50 Remote with the BMK

- **ME-RC50 Remote (Revision 2.6 or later):** Press the **METER** pushbutton on the ME-RC50 remote control, and then rotate the **SELECT** knob until the display shows the *05 BM: Setup* menu. When the *05 BM: Setup* menu appears, press the **SELECT** knob to display the *BM Charge Eff* menu item. Turn the **SELECT** knob until the *BM Amp Hours* menu item appears. Press the **SELECT** knob to display the current Batt Amphr setting. Turn the **SELECT** knob to adjust the Batt AmpHr setting. Press the **SELECT** knob to select and save the new setting.

3.4 ME-RC50 Remote's BMK METER Menu Maps

The diagram below is a complete overview of the battery monitor settings and information displays available from the ME-RC50 remote's METER menu.
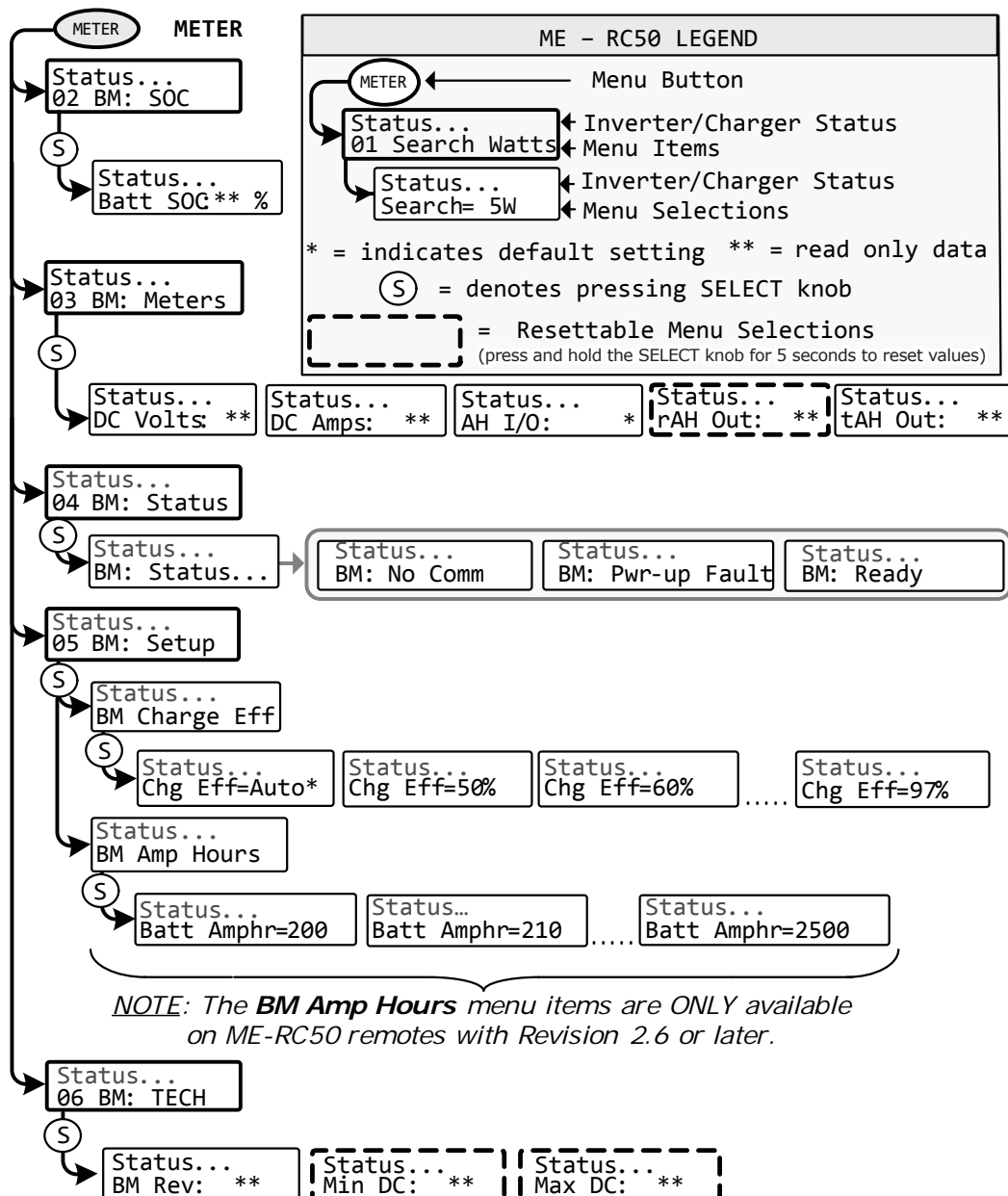

Figure 3-3, ME-RC50 METER Menu Map (Displays w/BMK Settings)

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3.5 Operating the BMK using the ME-RC50

This section explains how the ME-BMK battery monitor works, and how to use the Magnum Energy RC50 remote control to obtain battery bank information. It also covers the various LCD displays that are related to the battery monitor and the status of the Sense Module's LED indicator.

> **Info:** For additional information on navigating this remote control, see the ME-RC50 (PN: 64-0003) Owner's Manual.

3.5.1 How does the Battery Monitor (ME-BMK) Operate? The ME-BMK battery monitor uses a precision resistor known as a <u>shunt</u> to measure current flow into and out of the battery. The shunt provides a small voltage to the Sense Module that is proportional to the current flow. When current starts flowing into or out of the battery, the Sense Module measures the current flow and determines the amount of current removed from and returned to the battery. The amount of current (or amp-hours) removed or returned is displayed on the remote control as the AH I/O (Amp-Hours In/Out). The AH I/O number is compensated by a charging efficiency value that accounts for energy loses while charging, and is one of the factors used to determine the battery's State Of Charge (SOC).

The battery's state of charge — which is the best indicator of the condition of the batteries — is indicated on the *SOC* display. This display will show that the batteries are fully charged (i.e., SOC = 100%) once the following three conditions have been met:

1. The charging voltage has stabilized over a period of time.
2. The charging current has decreased to a low percentage of the amp-hour capacity – normally less than 2%.
3. The amp-hours that were removed from the battery are within 1% of fully being returned.

After the batteries have reached 100% SOC and have discharged ≥ 0.5% of the battery capacity setting, the charge efficiency value will be recalculated and the AH I/O read-out will reset to the recalculated value.

> **Info:** To help maintain the accuracy of the *SOC* display and to keep the batteries in good condition, they must on occasion be 100% charged (approximately once a week).

> **Info:** Charging from a generator (non-inverter topology) adds some concern about the cost of fuel. A balance should be considered between the use of fuel and the need to charge your batteries to 100% SOC – to maintain the full service life of a battery. Batteries discharged to 50% SOC and then normally recharged to 85-90% SOC would be an efficient compromise between fuel cost and battery life. Trying to restore the last 10-15% of a full battery charge requires a long time – typically several hours.

3.6 ME-RC50 METER Menu Items and Settings for BMK

Press the **METER** pushbutton on the ME-RC50 to access the different meters that determine the status of the inverter/charger and battery system.

Press the **METER** pushbutton	Rotate the **SELECT** knob to find your desired menu item	Press the **SELECT** knob to "select" your desired menu item
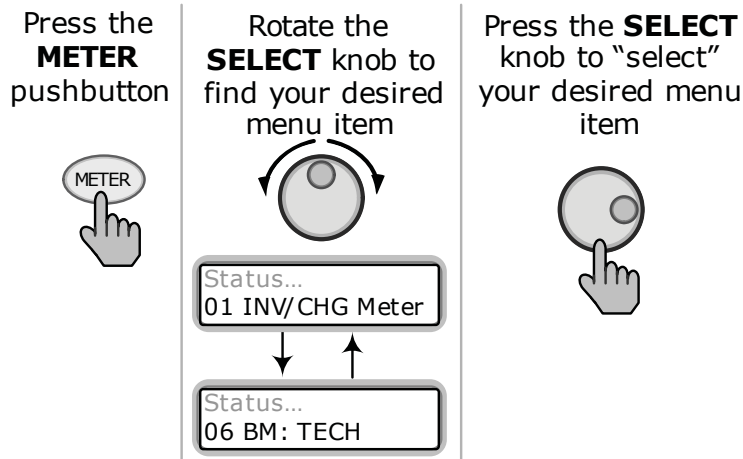
Figure 3-4, Accessing the METER Menu Items (ME-RC50)

01 INV/CHG Meter – This menu provides the DC voltage and current of the inverter/charger when inverting or charging. These are **not** BMK readings.

02 BM: SOC – This display is the best way to monitor the actual state of the battery. The read only display shows the State Of Charge (SOC) for the connected battery bank. The SOC represents the condition of the battery as a percentage of the available capacity left in the battery. The range is 0% to 100%, where 100% represents a fully charged battery and 0% means the battery is completely discharged.

When the Sense Module is first connected, the batteries will need to be fully charged (i.e., SOC = 100%) at least once to establish a SOC reference point. While this reference point is being calculated, the display will show "Think'n", to indicate that the SOC reference point is being calculated. After the batteries are fully charged, the display will change from "Think'n" to "100%" and begin to provide accurate SOC percentage values.

Info: "Think'n" can take up to several days depending on the charge source and its ability to completely recharge the batteries (e.g., a small PV array may not be large enough to replace all the amp-hrs in a reasonable amount of time).

If the Sense Module is disconnected from power, this display resets to "Think'n" and the batteries will require another full charge before this display begins providing SOC percentage information.

Info: Try to limit battery discharging to 50% of capacity (keep battery above 50% SOC). If batteries are allowed to be continually discharged below 50% SOC, their effective service life will be considerably shorter. This 50% rule has been determined to be the best compromise between available energy and the maximum number of discharge cycles a battery can provide.

03 BM: Meters – This menu shows the battery bank's DC voltage, DC current, and AH information that has been provided by the battery meter. The values for these meter displays are updated each second.

- **DC Volts** – This meter displays the real-time battery voltage from 07.00 to 70.00 volts (± 0.02 volts).

- **DC Amps** – This meter displays the real-time charge current (amps into the battery) or discharge current (amps out of the battery). Charging is shown as a positive (+) number and discharging is shown as a negative (-) number. The range is from ±0.1 to 999 amps, with a 1.0% accuracy.

- **AH I/O** (**Amp-Hours In/Out**) – This meter displays the amp-hours returned to or removed from the battery. When this value is positive, it represents amp-hours returned to the battery during any subsequent charging. A negative value represents amp-hours removed from a full battery. The range is ±32,768 AH.

  When using the charge efficiency's *Auto* setting, the AH I/O value is recalculated after the battery has been fully charged (reaching 100% SOC) and ≥0.5% of the battery capacity has been discharged. If the Sense Module is disconnected from power, the displayed AH I/O value resets to zero.

  > **Info:** The *AH I/O* display correlates with the battery amp-hours setting to help determine the *02 BM: SOC* display.

  > **Info:** AH I/O example; if you run a 10 amp load for three hours, the display will show -30 AH. When you begin charging, the display will count from -30 AH back toward 0 AH.

- **rAH Out** (**Resettable Amp-Hours Removed**) – This meter displays the total amp-hours removed from the battery since it was last reset. This display can be used as a battery load indicator to help identify and monitor the battery load consumption. The range is 0 to 65,535.0 amp-hours (0.1 amp-hour resolution).

  To reset the AmpHrs value to zero, press and hold the rotary **SELECT** knob for >5 seconds when this display is shown. After this display has been reset, it will begin calculating and displaying new rAH Out values. This display automatically resets to zero if the Sense Module is disconnected from power.

- **tAH Out** (**Total Amp-Hours Removed**) – This meter displays the total amp-hours removed from the battery since the Sense Module was first connected. This display can be used as a battery service life indicator. The value is displayed in 0.1k [or 100 amp-hours ("k" equals 1000)] resolution up to a maximum of 6,553.5k amp-hours (6,553,500 amp-hours). The displayed number resets to 0.0k when the Sense Module is disconnected from power.

04 BM: Status – This menu selection offers read only displays that give the current operating status of the battery monitor. This selection also provides information to determine if there is a power-up fault condition.

- **BM: Pwr-up Fault** – The battery monitor faulted when it was powered-up. The fault occurred because the power-up self-test failed. See the Troubleshooting section.

- **BM: No Comm** – The battery monitor is not communicating with the remote. This typically means a ME-BMK is not installed in the system. If installed, view the Sense Module LED and use Table 6-1 to help determine the issue.

- **BM: Ready** – The battery monitor is connected and actively monitoring the battery system.

05 BM: Setup – This menu allows the battery's charging efficiency to be automatically calculated or manually selected. Normally, the charging efficiency is automatically calculated (default setting is *Auto*). If you know your battery's efficiency and want information on changing this setting from the *Auto* selection, return to the Setup section of this manual.

> **Info:** ME-RC50 remotes with a revision of 2.6 or later have the *Batt AmpHr* function also available from this menu. Refer to Section 3.3 for more info.

06 BM: TECH – These menu selections allow you to access the system information used to assist service technicians in troubleshooting the battery monitor or the charging system.

- **BM Rev** – This read only menu displays the firmware revision level of the connected battery monitor. If the battery monitor is not connected or not communicating, the display will show "0.0".

- **Min DC** – This menu displays the lowest battery voltage since the last reset. The voltage shown on the display is averaged each second, and is helpful when troubleshooting or detecting an over-discharge condition.

  To reset this display, press and hold the rotary **SELECT** knob for 5 seconds while the *Min DC* display is shown. After this value has been reset, the display will begin monitoring and showing new minimum DC input values. If the battery monitor is not connected or not communicating, the display will show "0.0".

- **Max DC** – This menu displays the highest battery voltage since the last reset. The voltage shown on the display is averaged each second, and this allows you to check your charging system (battery charger, charge controller, etc.) to ensure the charging voltage has been attained. This display is also helpful when troubleshooting or detecting if an over-charge condition has occurred.

  To reset this display, press and hold the rotary **SELECT** knob for 5 seconds while the *Max DC* display is shown. After this value has been reset, the display will begin monitoring and showing new maximum DC input values. If the battery monitor is not connected or not communicating, the display will show "0.0".

4.0 Using the ME-ARC50 Remote with the BMK

This section discusses how to set up and operate the BMK using the ME-ARC50 remote. It also shows what BMK menu options are available using this remote.

The first section provides information about Charge Efficiency and how to manually access/adjust this setting. Normally, the ME-BMK battery monitor automatically calculates the battery's efficiency.

> **Info:** The factory default charge efficiency setting is *Auto.* This setting allows the charging efficiency to be automatically calculated. In most circumstances, the *Auto* setting will determine the best charge efficiency.

> **CAUTION:** If you do not know your battery's charging efficiency, leave it at the factory default setting. If the setting is manually set but incorrect, the state-of-charge information will become more inaccurate with every charge.

What is Charge Efficiency? When a certain amount of energy is removed or discharged from the battery, this removed energy will need to be returned to keep the batteries at a 100% state of charge. As batteries are being charged, they lose energy; either in the form of heat, or while gassing. This loss of energy while charging means the battery will not be fully charged if you only return the current that was removed. To compensate for the battery's inefficiencies while charging, a charge efficiency setting is provided. The charge efficiency setting compensates the AH I/O (Amp-Hrs In/Out) reading by ensuring the amp-hrs returned to the battery are greater than the amp-hrs removed.

For example, if your AH I/O display reads 000 and you begin powering a 25 amp load for two hours, the display will show -050. This indicates that you have discharged 50 amp-hrs (2 x 25) from the battery. If the charge efficiency setting is set to 95%, then as you begin charging and return 50 amp-hrs, the AH I/O reading will be less than zero, indicating that the amp-hours removed have not been fully returned. The 95% charge efficiency setting requires 52.5 amp-hours (50/95) to be returned before the AH I/O returns to 0.

4.1 Accessing the Charge Efficiency Menu Item

On the ME-ARC50 remote, press the **SETUP** pushbutton and rotate the **SELECT** knob until the *05 BMK Setup* menu appears. Once the *05 BMK Setup* menu appears, press the **SELECT** knob to access the 05A *Charge Eff* menu item (see Figure 4-1).

SETUP

press

rotate to

Status...
05 BMK Setup

press to select
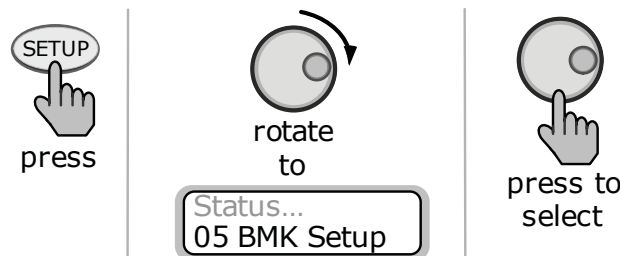
Figure 4-1, *Accessing the Charge Efficiency Menu Item (ME-ARC50)*

> **Info:** For additional information on navigating the remote display, see the ME-ARC50 (PN: 64-0030) Owner's Manual. See Figures 4-3 and 4-4 for complete maps of the menu items and adjustable settings available for the ME-BMK when using the ME-ARC50 remote control.

4.2 Adjusting the Charge Efficiency Setting

The Charge Efficiency setting allows the battery monitor to calculate the battery's charge efficiency. The charge efficiency can be calculated automatically using the *Auto* setting, or can be manually programmed by the user (see Figure 4-2).

The battery monitor is shipped with the charge efficiency set to *Auto.* This allows the battery monitor to automatically calculate variables that affect the charging efficiency such as battery type, battery age, and how the batteries are maintained – which is not always constant. With the *Auto* setting, the efficiency is recalculated each time the batteries reach a 100% state of charge.

This setting can also be manually adjusted from 50% to 97% if the battery's charge efficiency is known. When using a setting other than the *Auto* setting, the battery monitor will use the manual setting to calculate the AH I/O display. For example, if you set the charge efficiency to 90% and 100 amp-hrs are removed from the battery, the *AH Net* display would read 000 only after 111AH have been returned to the battery.
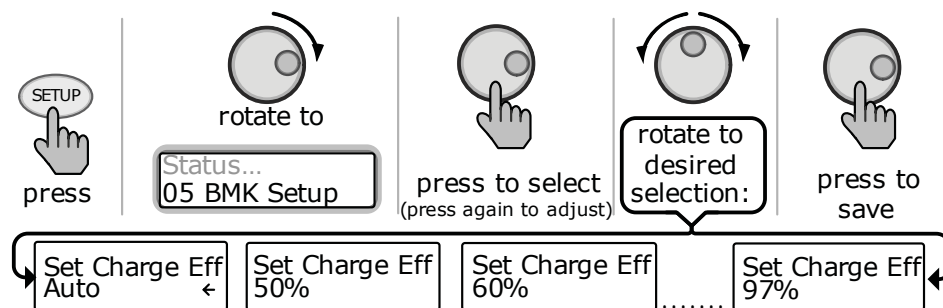

Figure 4-2, Adjusting the Charge Efficiency Setting (ME-ARC50)

If the charge efficiency is manually set and inaccurate, the SOC information will be more inaccurate with every charge. For this reason, continually monitor the AH I/O reading under the ME-ARC50 remote's **METER** pushbutton.

To access the AH I/O reading: press the **METER** pushbutton, turn the **SELECT** knob until the *04 BMK Meters* menu appears, and then press the **SELECT** knob. Turn the **SELECT** knob until the 04E *AH In/Out* display appears.

After several charge and discharge cycles (below 80% SOC), the AH I/O reading should be slightly positive when the *SOC* display reads 99%.

To view the *SOC* display: press the **METER** pushbutton and turn the **SELECT** knob until the *04 BMK Meters* menu appears. Press the **SELECT** knob, and then turn the **SELECT** knob until the *04B SOC* display appears. If the AH I/O reading is below 000 (negative number) when the *SOC* display reads 99%, then increase the charge efficiency setting. If you find that the AH I/O reading is substantially above zero when the *SOC* display reads 99%, then decrease the charge efficiency setting.

4.3 Adjusting the AmpHr Size Setting

It's important that the AmpHr Size setting is correct or else the calculations used to determine the battery's *SOC* display will be inaccurate.

To adjust the AmpHr Size setting: press the **SETUP** pushbutton and turn the **SELECT** knob until the *05 BMK Setup* menu appears. Press the **SELECT** knob to display the *05A Charge Eff* menu item. Turn the **SELECT** knob to display the *05B AmpHour Size* menu with the current AmpHrs Size setting shown. Press the **SELECT** knob to access the *Set AmpHr Size* function. Turn the **SELECT** knob to adjust the AmpHr Size setting. Press the **SELECT** knob to select and save the new setting.

4.4 ME-ARC50 Remote's BMK Menu Maps

The diagrams below are a complete overview of the battery monitor settings and information displays available from the ME-ARC50 remote's SETUP and METER menus.

ME - ARC50 LEGEND
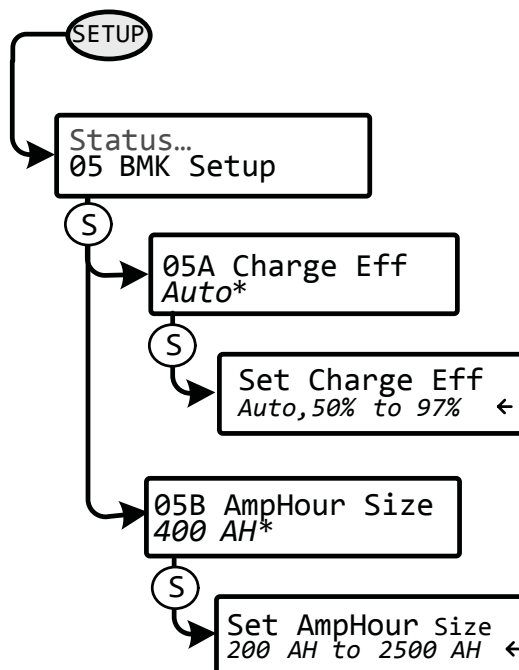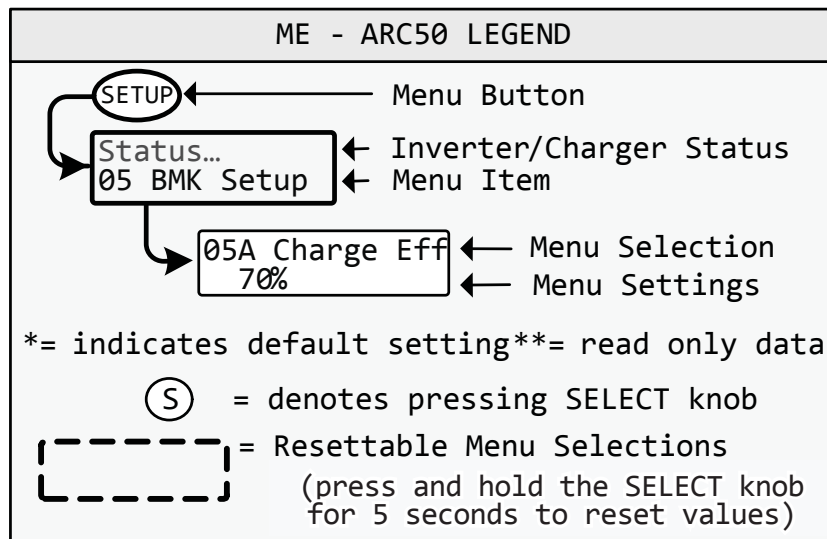
Figure 4-3, ME-ARC50 SETUP Menu Map (Displays w/BMK Settings)

METER

METER

Status…
04 BMK Meters

(S)

04A BMK Status
[Status]

Status:
BMK Ready
Power-up Fault
No Comm

04B SOC
** %

04C DC Volts-BMK
** VDC

04D DC Amps-BMK
** ADC

04E AH In/Out
** AH

04F Resettable AH
** AH

04G Total AH Out
**k AH

04H Minimum VDC
** VDC

04I Maximum VDC
** VDC

Figure 4-4, ME-ARC50 METER Menu Map (Displays w/BMK Settings)

4.5 Operating the BMK using the ME-ARC50

This section explains how the ME-BMK battery monitor works, and how to use the Magnum Energy ARC50 remote control to obtain battery bank information. It also covers the various LCD displays that are related to the battery monitor and the status of the Sense Module's LED indicator.

Info: For additional information on navigating the ARC50 remote control, see the ME-ARC50 (PN: 64-0030) Owner's Manual.

4.5.1 How does the Battery Monitor (ME-BMK) Operate? The ME-BMK battery monitor uses a precision resistor known as a <u>shunt</u> to measure current flow into and out of the battery. The shunt provides a small voltage to the Sense Module that is proportional to the current flow. When current starts flowing into or out of the battery, the Sense Module meas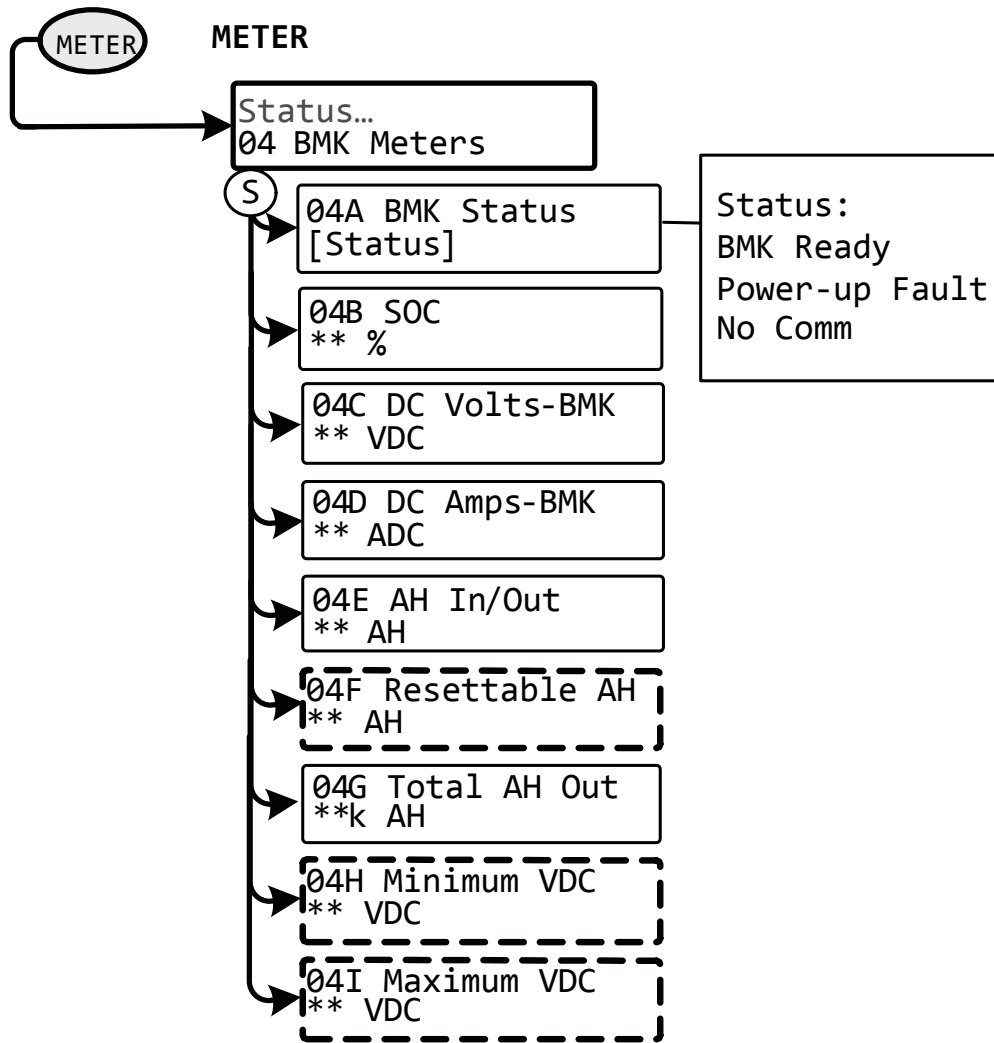ures the current flow and determines the amount of current removed from and returned to the battery. The amount of current (or amp-hours) removed or returned is displayed on the remote control as the AH I/O (Amp-Hours In/Out). The AH I/O number is compensated by a charging efficiency value that accounts for energy loses while charging, and is one of the factors used to determine the battery's State Of Charge (SOC).

The battery's state of charge — which is the best indicator of the condition of the batteries — is indicated on the *SOC* display. This display will show that the batteries are fully charged (i.e., SOC = 100%) once the following three conditions have been met:

1. The charging voltage has stabilized over a period of time.
2. The charging current has decreased to a low percentage of the amp-hour capacity – normally less than 2%.
3. The amp-hours that were removed from the battery are within 1% of fully being returned.

After the batteries have reached 100% SOC and have discharged ≥ 0.5% of the battery capacity setting, the charge efficiency value will be recalculated and the AH I/O read-out will reset to the recalculated value.

Info: To help maintain the accuracy of the *SOC* display and to keep the batteries in good condition, they must on occasion be 100% charged (approximately once a week).

Info: Charging from a generator (non-inverter topology) adds some concern about the cost of fuel. A balance should be considered between the use of fuel and the need to charge your batteries to 100% SOC – to maintain the full service life of a battery. Batteries discharged to 50% SOC and then normally recharged to 85-90% SOC would be an efficient compromise between fuel cost and battery life. Trying to restore the last 10-15% of a full battery charge requires a long time – typically several hours.

4.6 ME-ARC50 METER Menu Items and Settings for BMK

Press the **METER** pushbutton, and then turn the **SELECT** knob to the *04 BMK Meters* menu to access the different meters that determine the status of the battery system.

Press the **METER** pushbutton	Rotate the **SELECT** knob to:	Press the **SELECT** knob to "select" the *04 BMK Meters* menu item

Status…
04 BMK Meters
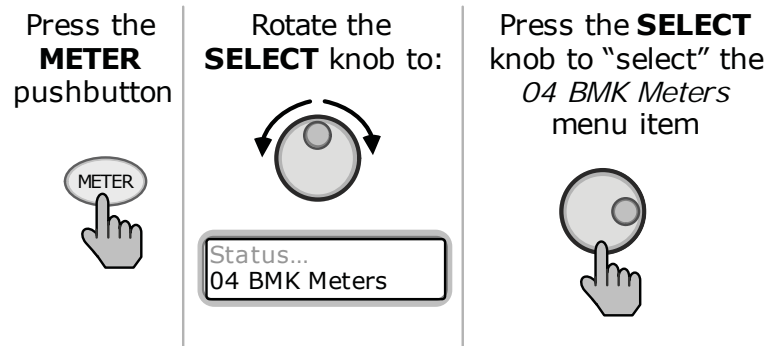
Figure 4-5, Accessing the METER Menu Items (ME-ARC50)

04A BMK Status – This menu selection offers read only displays that give the current operating status of the battery monitor. This selection also provides information to determine if there is a power-up fault condition.

- **BM: Pwr-up Fault** – The battery monitor faulted when it was powered-up. The fault occurred because the power-up self-test failed. See the Troubleshooting section.

- **BM: No Comm** – The battery monitor is not communicating with the remote. This typically means a ME-BMK is not installed in the system. If installed, view the Sense Module LED and use Table 6-1 to help determine the issue.

- **BM: Ready** – The battery monitor is connected and actively monitoring the battery system.

04B SOC – This display is the best way to monitor the actual state of the battery. The read only display shows the State Of Charge (SOC) for the connected battery bank. The SOC represents the condition of the battery as a percentage of the available capacity left in the battery. The range is 0% to 100%, where 100% represents a fully charged battery and 0% means the battery is completely discharged.

When the Sense Module is first connected, the batteries will need to be fully charged (i.e., SOC = 100%) at least once to establish a SOC reference point. While this reference point is being calculated, the display will show "Think'n", to indicate that the SOC reference point is being calculated. After the batteries are fully charged, the display will change from "Think'n" to "100%" and begin to provide accurate SOC percentage values.

If the Sense Module is disconnected from power, this display resets to "Think'n" and the batteries will require another full charge before this display begins providing SOC percentage information.

> **Info:** Try to limit battery discharging to 50% of capacity (keep battery above 50% SOC). If batteries are allowed to be continually discharged below 50% SOC, their effective service life will be considerably shorter. This 50% rule has been determined to be the best compromise between available energy and the maximum number of discharge cycles a battery can provide.

04C DC Volts-BMK – This meter displays the real-time battery voltage from 07.00 to 70.00 volts (± 0.02 volts).

04D DC Amps-BMK – This meter displays the real-time charge current (amps into the battery) or discharge current (amps out of the battery). Charging is shown as a positive (+) number and discharging is shown as a negative (-) number. The range is from ±0.1 to 999 amps, with a 1.0% accuracy.

04E AH In/Out – This meter displays the amp-hours returned to or removed from the battery. When this value is positive, it represents amp-hours returned to the battery during any subsequent charging. A negative value represents amp-hours removed from a full battery. The range is ±32,768 AH.

When using the charge efficiency's *Auto* setting, the AH I/O value is recalculated after the battery has been fully charged (reaching 100% SOC) and ≥0.5% of the battery capacity has been discharged. If the Sense Module is disconnected from power, the displayed AH I/O value resets to zero.

> **Info:** The *AH I/O* display correlates with the *05B AmpHour Size* setting (under **SETUP** button) to help determine the *04B SOC* display. AH I/O example – if you run a 10 amp load for three hours, the display will show -30 AH. When you begin charging, the display will count from -30 AH back toward 0 AH.

04F Resetable AH – This meter displays the total amp-hours removed from the battery since it was last reset. This display can be used as a battery load indicator to help identify and monitor the battery load consumption. The range is 0 to 65,535.0 amp-hours (0.1 amp-hour resolution).

To reset the AmpHrs value to zero, press and hold the rotary **SELECT** knob for >5 seconds when the *Resetable AH* display is shown. After this display has been reset, it will begin calculating and displaying new rAH Out values. This display automatically resets to zero if the Sense Module is disconnected from power.

04G Total AH Out – This meter displays the total amp-hours removed from the battery since the Sense Module was first connected. This display can be used as a battery service life indicator. The value is displayed in 0.1k [or 100 amp-hours ("k" equals 1000)] resolution up to a maximum of 6,553.5k amp-hours (6,553,500 amp-hours). The displayed number resets to 0.0k when the Sense Module is disconnected from power.

04H Minimum VDC – This menu displays the lowest battery voltage since the last reset. The voltage shown on the display is averaged each second, and is helpful when troubleshooting or detecting an over-discharge condition. To reset this display, press and hold the rotary **SELECT** knob for 5 seconds while the *Minimum VDC* display is shown. After this value has been reset, the display will begin monitoring and showing new minimum DC input values. If the battery monitor is not connected or not communicating, the display will show "0.0".

04I Maximum VDC – This menu displays the highest battery voltage since the last reset. The voltage shown on the display is averaged each second, and this allows you to check your charging system (battery charger, charge controller, etc.) to ensure the charging voltage has been attained. This display is also helpful when troubleshooting or detecting if an over-charge condition has occurred. To reset this display, press and hold the rotary **SELECT** knob for 5 seconds while the *Maximum VDC* display is shown. After this value has been reset, the display will begin monitoring and showing new maximum DC input values. If the battery monitor is not connected or not communicating, the display will show "0.0".

5.0 Using the ME-RTR Router with the BMK

This section discusses how to set up and operate the BMK using the ME-RTR router. It also shows what BMK menu options are available using the router.

The first section provides information about Charge Efficiency and how to manually access/adjust this setting. Normally, the ME-BMK battery monitor automatically calculates the battery's efficiency.

> **Info:** The factory default charge efficiency setting is *Auto.* This setting allows the charging efficiency to be automatically calculated. In most circumstances, the *Auto* setting will determine the best charge efficiency.

> **CAUTION:** If you do not know your battery's charging efficiency, leave it at the factory default setting. If the setting is manually set but incorrect, the state-of-charge information will become more inaccurate with every charge.

What is Charge Efficiency? When a certain amount of energy is removed or discharged from the battery, this removed energy will need to be returned to keep the batteries at a 100% state of charge. As batteries are being charged, they lose energy; either in the form of heat, or while gassing. This loss of energy while charging means the battery will not be fully charged if you only return the current that was removed. To compensate for the battery's inefficiencies while charging, a charge efficiency setting is provided. The charge efficiency setting compensates the AH I/O (Amp-Hrs In/Out) reading by ensuring the amp-hrs returned to the battery are greater than the amp-hrs removed.

For example, if your AH I/O display reads 000 and you begin powering a 25 amp load for two hours, the display will show -050. This indicates that you have discharged 50 amp-hrs (2 x 25) from the battery. If the charge efficiency setting is set to 95%, then as you begin charging and return 50 amp-hrs, the AH I/O reading will be less than zero, indicating that the amp-hours removed have not been fully returned. The 95% charge efficiency setting requires 52.5 amp-hours (50/95) to be returned before the AH I/O returns to 0.

5.1 Accessing the Charge Efficiency Menu Item

On the ME-RTR router, navigate to the BMK Home screen (see the ME-RTR Owner's Manual, PN: 64-0030, for information on how to access the router's BMK Home screen). Press the **SETUP** pushbutton, and then rotate the **SELECT** knob until the *05A Charge Eff* menu appears (see Figure 5-1). Press the **SELECT** knob to access the *Set Charge Eff* function where you can adjust the current charge efficiency setting.
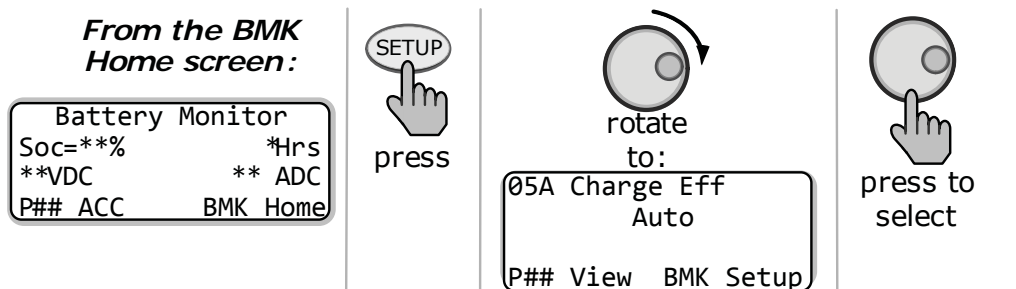

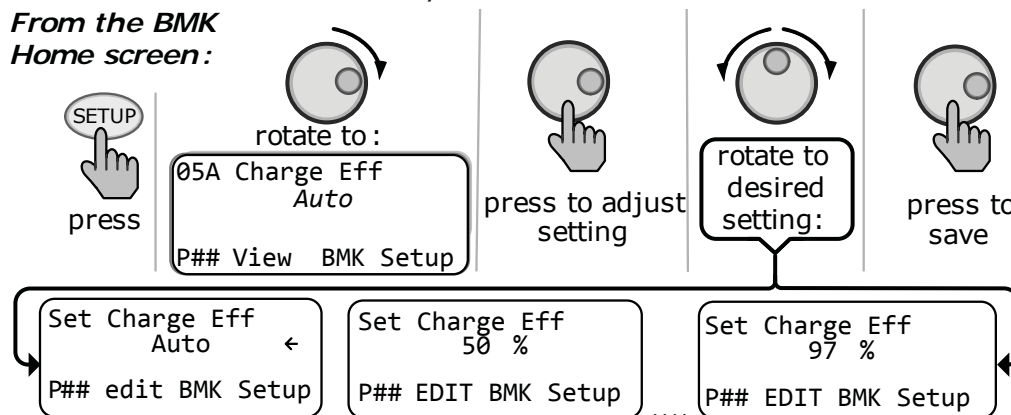*Figure 5-1, Accessing the Charge Efficiency Menu Item (ME-RTR)*

5.2 Adjusting the Charge Efficiency Setting

The Charge Efficiency setting allows the battery monitor to calculate the battery's charge efficiency. The charge efficiency can be calculated automatically using the *Auto* setting, or can be manually programmed by the user (see Figure 5-2).

The battery monitor is shipped with the charge efficiency set to *Auto.* This allows the battery monitor to automatically calculate variables that affect the charging efficiency such as battery type, battery age, and how the batteries are maintained – which is not always constant. With the *Auto* setting, the efficiency is recalculated each time the batteries reach a 100% state of charge.

This setting can also be manually adjusted from 50% to 97% if the battery's charge efficiency is known. When using a setting other than the *Auto* setting, the battery monitor will use the manual setting to calculate the AH I/O display. For example, if you set the charge efficiency to 90% and 100 amp-hrs are removed from the battery, the *AH Net* display would read 000 only after 111AH have been returned to the battery.

Figure 5-2, *Adjusting the Charge Efficiency Setting (ME-RTR)*

If the charge efficiency is manually set and inaccurate, the SOC information will be more inaccurate with every charge. For this reason, continually monitor the AH I/O reading under the router's **METER** pushbutton.

To access the AH I/O reading: from the BMK Home screen, press the **METER** pushbutton. The *04A BMK SOC* display appears. Turn the **SELECT** knob until the *04D AH In/Out* menu appears.

After several charge and discharge cycles (below 80% SOC), the AH I/O reading should be slightly positive when the *SOC* display reads 99%.

To view the *SOC* display: from the BMK Home screen, press the **METER** pushbutton. The *04A BMK SOC* menu appears. If the AH I/O reading is below 000 (negative number) when the *SOC* display reads 99%, then increase the charge efficiency setting. If you find that the AH I/O reading is substantially above zero when the *SOC* display reads 99%, then decrease the charge efficiency setting.

5.3 Adjusting the AmpHrs Setting

It's important that the AmpHrs setting is correct or else the calculations used to determine the battery's *SOC* display will be inaccurate.

To adjust this setting: from the BMK Home screen, press the **SETUP** pushbutton. Turn the **SELECT** knob until the *05B AmpHrs Size* display appears. Press the **SELECT** knob to access the *Set AmpHrs Size* function. Turn the **SELECT** knob to adjust the AmpHrs setting. Press the **SELECT** knob to select and save the new setting.

5.4 ME-RTR Router's BMK Menu Maps

The diagrams below are a complete overview of the battery monitor settings and information displays available from the ME-RTR router's SETUP and METER menus.
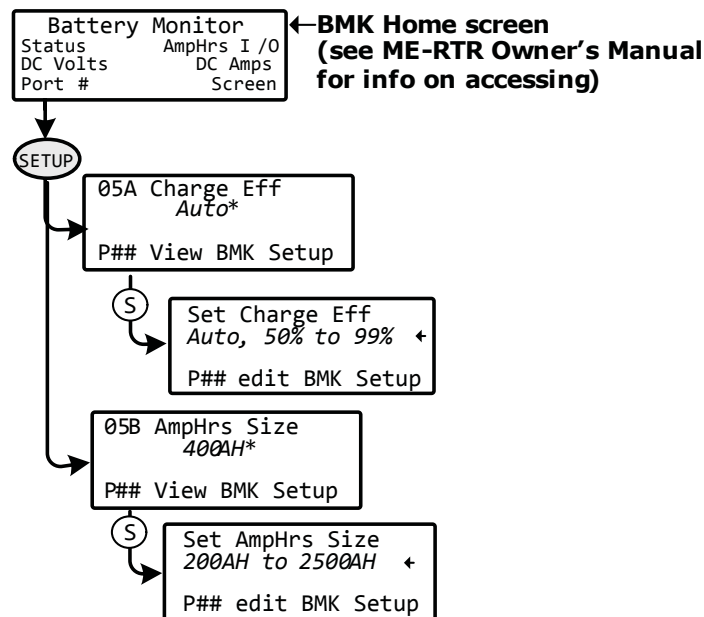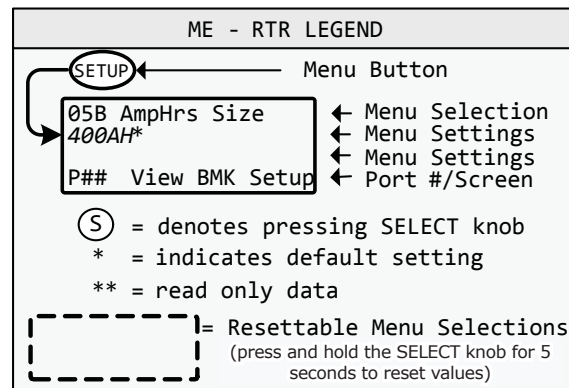
Figure 5-3, ME-RTR SETUP Menu Map (Displays w/BMK Settings)

```
        Battery Monitor      ◄── BMK Home screen
Status           AmpHrs I/O      (see ME-RTR Owner's Manual
DC Volts          DC Amps        for info on accessing)
Port #             Screen
```

METER   (METER)

```
┌──────────────────────────┐   ┌──────────────────────────┐
│04A BMK SOC               │   │04B DC Volts-BMK          │
│         ** %             │   │         ** VDC           │
│                          │   │                          │
│P#A   View    BMK Meter   │   │P#A   View    BMK Meter   │
└──────────────────────────┘   └──────────────────────────┘

┌──────────────────────────┐   ┌──────────────────────────┐
│04D AH In/Out             │   │04C DC Amps-BMK           │
│         ** AHrs          │   │         ** ADC           │
│                          │   │                          │
│P#A   View    BMK Meter   │   │P#A   View    BMK Meter   │
└──────────────────────────┘   └──────────────────────────┘

┌ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ┐   ┌──────────────────────────┐
│04E Resetable AHrs        │   │04F Total kAHrs Out       │
│        **Ahrs            │   │         ** kAH           │
│                          │   │                          │
│P#A   View   BMK Meter    │   │P#A   View    BMK Meter   │
└ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ┘   └──────────────────────────┘

┌ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ┐   ┌ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ┐
│04H Maximum VDC           │   │04G Minimum VDC           │
│         ** VDC           │   │         ** VDC           │
│                          │   │                          │
│P#A   View   BMK Meter    │   │P#A   View   BMK Meter    │
└ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ┘   └ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ┘
```
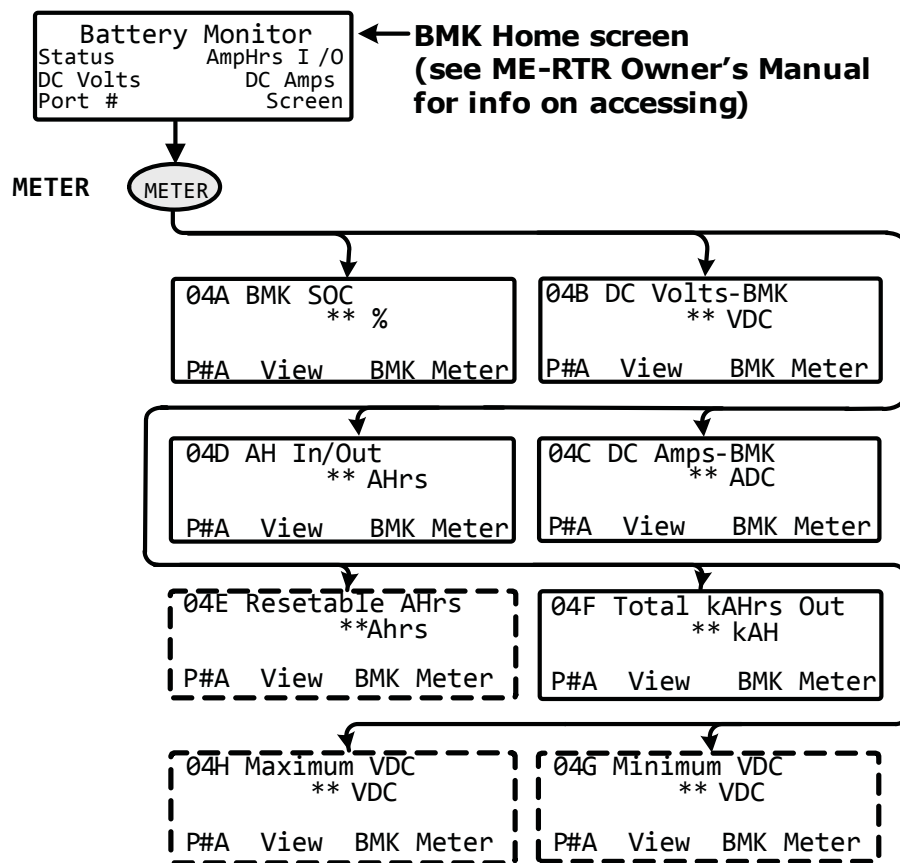
Figure 5-4, ME-RTR METER Menu Map (Displays w/BMK Settings)

5.5 Operating the BMK using the ME-RTR

This section explains how the ME-BMK battery monitor works, and how to use the Magnum Energy RTR router to obtain battery bank information. It also covers the various LCD displays that are related to the battery monitor and the status of the Sense Module's LED indicator.

> **Info:** Battery monitor menu items are accessed via the RTR router's BMK Home screen. For information on how to access the BMK Home screen or otherwise navigate the RTR router, see the ME-RTR (PN: 64-0020) Owner's Manual.

5.5.1 How does the Battery Monitor (ME-BMK) Operate? The ME-BMK (battery monitor kit) uses a precision resistor known as a shunt to measure current flow into and out of the battery. The shunt provides a small voltage to the Sense Module that is proportional to the current flow. When current starts flowing into or out of the battery, the Sense Module measures the current flow and determines the amount of current removed from and returned to the battery. The amount of current (or amp-hours) removed or returned is displayed on the router as the AH I/O (Amp-Hours In/Out). The AH I/O number is compensated by a charging efficiency value that accounts for energy loses while charging, and is one of the factors used to determine the battery's State Of Charge (SOC).

Using the ME-RTR Router with the BMK

The battery's state of charge — which is the best indicator of the condition of the batteries — is indicated on the *SOC* display. This display will show that the batteries are fully charged (i.e., SOC = 100%) once the following three conditions have been met:

1. The charging voltage has stabilized over a period of time.
2. The charging current has decreased to a low percentage of the amp-hour capacity – normally less than 2%.
3. The amp-hours that were removed from the battery are within 1% of fully being returned.

After the batteries have reached 100% SOC and have discharged ≥ 0.5% of the battery capacity setting, the charge efficiency value will be recalculated and the AH I/O read-out will reset to the recalculated value.

> **Info:** To help maintain the accuracy of the *SOC* display and to keep the batteries in good condition, they must on occasion be 100% charged (approximately once a week).

> **Info:** Charging from a generator (non-inverter topology) adds some concern about the cost of fuel. A balance should be considered between the use of fuel and the need to charge your batteries to 100% SOC – to maintain the full service life of a battery. Batteries discharged to 50% SOC and then normally recharged to 85-90% SOC would be an efficient compromise between fuel cost and battery life. Trying to restore the last 10-15% of a full battery charge requires a long time – typically several hours.

5.6 ME-RTR METER Menu Items and Settings for BMK

From the BMK Home screen, press the **METER** pushbutton, and then turn the **SELECT** knob on the ME-RTR router to access the different meters that determine the status of the battery system.
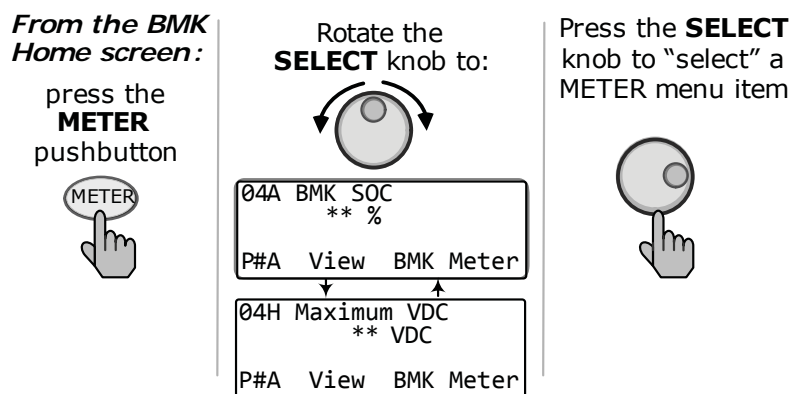
Figure 5-5, Accessing the METER Menu Items (ME-RTR)

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04A BMK SOC – This menu selection offers read only displays that give the current operating status of the battery monitor if there is a fault condition.

- **BM: Pwr-up Fault** – The battery monitor faulted when it was powered-up. The fault occurred because the power-up self-test failed. See the Troubleshooting section.

- **BM: No Comm** – The battery monitor is not communicating with the router. This typically means a ME-BMK is not installed in the system. If installed, view the Sense Module LED and use Table 6-1 to help determine the issue.

- **BM: Ready (will not display)** – The battery monitor is connected and actively monitoring the battery system. Router will display the battery's current state of charge (SOC).

The *SOC* display is the best way to monitor the actual state of the battery. The read only display shows the state of charge for the connected battery bank. The SOC represents the condition of the battery as a percentage of the available capacity left in the battery. The range is 0% to 100%, where 100% represents a fully charged battery and 0% means the battery is completely discharged.

When the Sense Module is first connected, the batteries will need to be fully charged (i.e., SOC = 100%) at least once to establish a SOC reference point. While this reference point is being calculated, the display will show "Think'n", to indicate that the SOC reference point is being calculated. After the batteries are fully charged, the display will change from "Think'n" to "100%" and begin to provide accurate SOC percentage values.

If the Sense Module is disconnected from power, this display resets to "Think'n" and the batteries will require another full charge before this display begins providing SOC percentage information.

> **Info:** Try to limit battery discharging to 50% of capacity (keep battery above 50% SOC). If batteries are allowed to be continually discharged below 50% SOC, their effective service life will be considerably shorter. This 50% rule has been determined to be the best compromise between available energy and the maximum number of discharge cycles a battery can provide.**04B DC Volts-BMK** – This meter displays the real-time battery voltage from 07.00 to 70.00 volts (± 0.02 volts).

04C DC Amps-BMK – This meter displays the real-time charge current (amps into the battery) or discharge current (amps out of the battery). Charging is shown as a positive (+) number and discharging is shown as a negative (-) number. The range is from ±0.1 to 999 amps, with a 1.0% accuracy.

04D AH In/Out – This meter displays the amp-hours returned to or removed from the battery. When this value is positive, it represents amp-hours returned to the battery during any subsequent charging. A negative value represents amp-hours removed from a full battery. The range is ±32,768 AH.

When using the charge efficiency's *Auto* setting, the AH I/O value is recalculated after the battery has been fully charged (reaching 100% SOC) and ≥0.5% of the battery capacity has been discharged. If the Sense Module is disconnected from power, the displayed AH I/O value resets to zero.

> **Info:** The *AH I/O* display correlates with the *05B AmpHrs Size* setting (under **SETUP** button) to help determine the *04A SOC* display. AH I/O example – if you run a 10 amp load for three hours, the display will show -30 AH. When you begin charging, the display will count from -30 AH back toward 0 AH.

04E Resetable AHrs –This meter displays the total amp-hours removed from the battery since it was last reset. This display can be used as a battery load indicator to help identify and monitor the battery load consumption. The range is 0 to 65,535.0 amp-hours (0.1 amp-hour resolution).

To reset the AmpHrs value to zero, press and hold the rotary **SELECT** knob for >5 seconds when this display is shown. After this display has been reset, it will begin calculating and displaying new rAH Out values. This display automatically resets to zero if the Sense Module is disconnected from power.

04F Total kAHrs Out – This meter displays the total amp-hours removed from the battery since the Sense Module was first connected. This display can be used as a battery service life indicator. The value is displayed in 0.1k [or 100 amp-hours ("k" equals 1000)] resolution up to a maximum of 6,553.5k amp-hours (6,553,500 amp-hours). The displayed number resets to 0.0k when the Sense Module is disconnected from power.

04G Minimum VDC – This menu displays the lowest battery voltage since the last reset. The voltage shown on the display is averaged each second, and is helpful when troubleshooting or detecting an over-discharge condition. To reset this display, press and hold the rotary **SELECT** knob for 5 seconds while the *Minimum VDC* display is shown. After this value has been reset, the display will begin monitoring and showing new minimum DC input values. If the battery monitor is not connected or not communicating, the display will show "0.0".

04H Maximum VDC – This menu displays the highest battery voltage since the last reset. The voltage shown on the display is averaged each second, and this allows you to check your charging system (battery charger, charge controller, etc.) to ensure the charging voltage has been attained. This display is also helpful when troubleshooting or detecting if an over-charge condition has occurred. To reset this display, press and hold the rotary **SELECT** knob for 5 seconds while the *Maximum VDC* display is shown. After this value has been reset, the display will begin monitoring and showing new maximum DC input values. If the battery monitor is not connected or not communicating, the display will show "0.0".

6.0 Using the LED Indicator to Determine the BMK's Status

There is a bi-color LED indicator on the front of the Sense Module to indicate the battery monitor's status. When the Sense Module is first powered up, the LED blinks red and green while going through a self-test. Once the self-test is complete, use the table below and the LED indicator on your BMK Sense Module to determine the BMK's operating status.

If the Sense Module does not function correctly, use Table 7-1 to help find a solution.

Table 6-1, LED Indicator Guide

LED Status	Meaning
OFF	1. No power to Sense Module. Check for correct DC voltage (7 to 70 VDC) and correct polarity from pin 3 (-) to pin 4 (+) on the terminal block; or, 2. Ensure the terminal block is correctly seated into the Sense Module.
Red ON, **Green** ON, **Red** On, **Green** ON	Power-up sequence (1 second interval between each color). The Sense Module is performing a self-test – this occurs when first connected to power.
Green ON	Normal operation: the Sense Module is correctly transmitting and receiving with network devices.
Green BLINKING	Not able to communicate with remote display. A. If the remote/router display is off; refer to the remote/router owner's manual for troubleshooting. Ensure the inverter is on and the correct communication cable is connected to the REMOTE port on the inverter. B. If the RC50 remote display is on; ensure the remote display is revision 2.0 or higher. RC50 remote displays with revisions prior to 2.0 are not compatible with the ME-BMK.
Red ON	The power-up sequence failed. Unplug the 4-port terminal block from the Sense Module and check for correct DC voltage on pins 3 and 4 (must be between 7 to 70 volts DC depending on the nominal voltage of the inverter).
Red BLINKING	No communication, or an unrecognizable communication on the network. Check the communication cable; ensure it is connected correctly. If the ME-BMK communication cable is missing, a standard 2-conductor telephone cable may be temporarily substituted. **Important:** Ensure the RJ11 connector is pushed into the correct port; you should feel/hear a "click" when the connection is made.

7.0 Troubleshooting

Info: Before using this table to troubleshoot, review Table 6-1, LED Indicator Guide.

Use the table below and the *Status* display on your remote/router to determine the problem.
- ME-RC50 - **METER** pushbutton, *04 BM: Status* display
- ME-ARC50 - **METER** pushbutton, *04A BMK Status* display
- ME-RTR - **METER** pushbutton, *04A BMK SOC* display

Table 7-1, Troubleshooting Guide

| Symptom	Solution
1. Battery meter displays not responsive and giving incorrect readings; or, 2. *BM Status* = "No Comm" or "Pwr-up Fault"	Ensure LED on Sense Module is solid green (indicates normal operation). If not green, use Table 6-1, LED Indicator to troubleshoot. If the LED is green, disconnect the terminal block for 5 seconds and then reconnect to reset the Sense Module.
AH I/O reading resets	This is normal. After a full battery has discharged ≥ 0.5% of the its capacity, the AH I/O synchronizes and the value resets.
DC Volts reading is incorrect	Measure the voltage between the red (terminal 4/positive) and black (terminal 3/negative) wire on the terminal block in the Sense Module. If the voltage at the Sense Module and the voltage displayed on the remote's/router's display differ by more than 0.2 volts, then examine these wires for an open circuit or a bad connection. Reconnect or replace if necessary. Voltage from terminal 3 to 4 must be from 7 to 70 volts DC.
DC Amps reading is incorrect	Examine the twisted-pair wires (orange and blue) for an open circuit or bad connections. Reconnect or replace if necessary. Ensure the wires are fully twisted up to the Sense Module and to the DC shunt.
DC Amps polarity reading is reversed (i.e., positive while inverting and/or negative while battery charging)	The leads from the twisted-pair (orange and blue) to the shunt sense screws are reversed. Reverse the leads of the twisted-pair wire on the shunt or at the terminal block. See Figure 2-3 for the correct wiring sequence.
The *Min DC* or *Max DC* displays show 0.0 volts	The battery monitor is not communicating. Check that the connections to the Sense Module are correct.

8.0 Specifications

Sense Module   DC Shunt
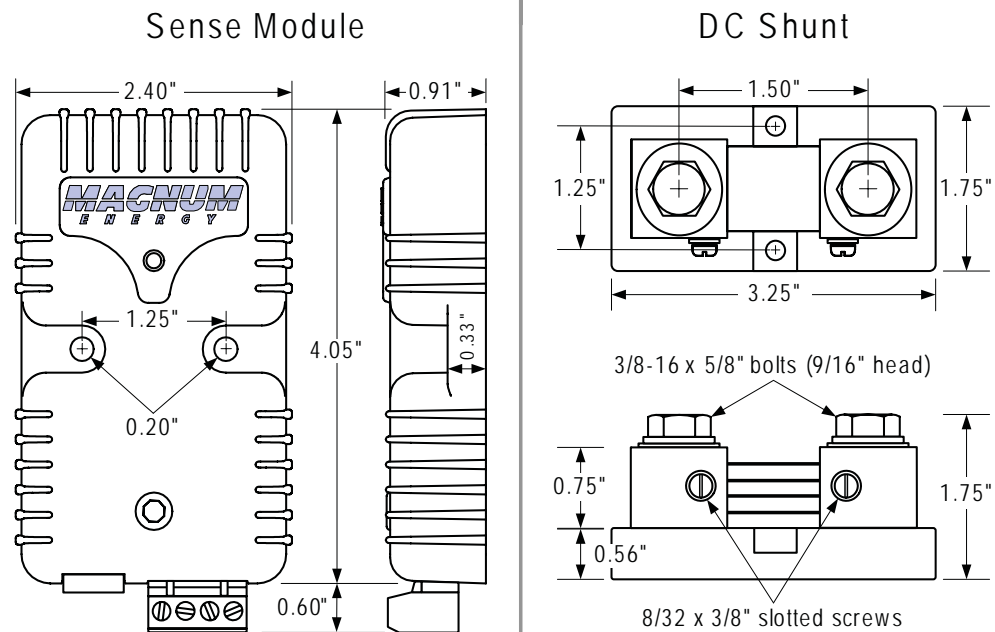
Figure 8-1, Dimensional Specifications

Table 8-1, Specifications

Sense Module/Meter Specifications	
DC Volts	7.00 - 70 volts (±0.5%) auto voltage detection
DC Amps	±0.1 to 999 (±1.0%)
Battery SOC %	0 to 100% (1% increments)
Power Draw	< .6 watts
AH I/O (In/Out)	±32,768 amp hours (1 AH increments)
rAH Out (Resettable Amp-Hours Removed)	0 to 65,535 amp hours, resettable (0.1 AH increments)
tAH Out (Total Amp-Hours Removed)	0 to 65,535,000 amp hours (0.1k or 100 AH increments)
Min/Max DC:	7 to 70 VDC, resettable
Shipping Weight:	~2 lbs. (Includes Manual, Sense Module, DC shunt, Twisted-pair wire and Communications cable)
Sense Wire	Twisted-pair (blue & orange), 5' length, 18AWG wire
Comm. Cable	2-conductor, 10' twisted-pair, telephone standard
DC Shunt Specifications	
Resistance:	0.1 milliohm (500 amps at 50 millivolts)
Continuous current:	410 amperes maximum
Overload current:	Can take overloads to 500 amps for less than 5 minutes if normally operated at less than 300 amps.

9.0 Limited Warranty

Magnum Energy, Inc., warrants the ME-BMK battery monitor to be free from defects in material and workmanship that result in product failure during normal usage, according to the following terms and conditions:

1. The limited warranty for this product extends for 12 months from the product's original date of purchase.

2. The limited warranty extends to the original purchaser of the product and is not assignable or transferable to any subsequent purchaser.

3. During the limited warranty period, Magnum Energy will repair, or replace at Magnum Energy's option, any defective parts, or any parts that will not properly operate for their intended use with factory new or remanufactured replacement items if such repair or replacement is needed because of product malfunction or failure during normal usage. The limited warranty does not cover defects in appearance, cosmetic, decorative or structural parts or any non-operative parts. Magnum Energy's limit of liability under the limited warranty shall be the actual cash value of the product at the time the original purchaser returns the product for repair, determined by the price paid by the original purchaser. Magnum Energy shall not be liable for any other losses or damages.

4. Upon request from Magnum Energy, the original purchaser must prove the product's original date of purchase by a dated bill of sale, itemized receipt.

5. The original purchaser shall return the product prepaid to Magnum Energy in Everett, WA. After the completion of service under this limited warranty, Magnum Energy will return the product prepaid to the original purchaser via a Magnum-selected non-expedited surface freight within the contiguous United States and Canada; this excludes Alaska and Hawaii.

6. If Magnum repairs or replaces a product (with either a new or remanu-factured product), its warranty continues for the remaining portion of the original warranty period or 90 days from the date of the return shipment to the original purchaser, whichever is greater. All replaced products and parts removed from repaired products become the property of Magnum Energy.

7. This limited warranty is voided if:

- the product has been modified without authorization

- the serial number has been altered or removed

- the product has been damaged through abuse, neglect, accident, high voltage or corrosion

- the product was not installed and operated according to the owner's manual

BEFORE RETURNING ANY UNIT, CONTACT MAGNUM ENERGY FOR A RETURN MATERIAL AUTHORIZATION (RMA) NUMBER.

9.1 How to Receive Repair Service

If your Product requires warranty service or repair, contact either:

1. An Authorized Service Center, which are listed on the Magnum Energy Website at http://www.magnumenergy.com/ServiceCenters.htm, or
2. Magnum Energy, Inc. at:

      Telephone: 425-353-8833
      Fax: 425-353-8390
      Email: warranty@magnumenergy.com

If returning your Product directly to Magnum Energy for repair, you must:
- return the unit in the original, or equivalent, shipping container
- receive a Return Materials Authorization (RMA) number from the factory prior to the return of the Product to Magnum Energy for repair
- place RMA numbers clearly on the shipping container or on the packing slip

When sending your Product for service, please ensure it is properly packaged. **Damage due to inadequate packaging is not covered under warranty.** We recommend sending the Product by traceable or insured service.

MAGNUM
E N E R G Y

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